Remarks and Arguments

Claims 1-4, 11, 13, 14, 22-26, 33 and 37 were rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent Application Publication No. US 2004/0094702 ("Clemmer") in view of U.S. Patent No. 6,586,732 ("Lee"). In making this rejection, the examiner has stated that Clemmer discloses a hybrid ion mobility spectrometer (IMS) and time-of-flight (TOF) mass spectrometer that includes a drift tube and a port connected to a source of gas that flows through the drift tube in an direction opposite that of the ion travel through the tube. The examiner goes on to state that Clemmer does not teach the use of an ion generator that generates an ion cloud at atmospheric pressure, use of an electrospray apparatus with a capillary and strong electric field or a method of establishing an electric field in the IMS drift tube. He therefore cites the Lee reference as showing these elements.

One of the first things that can be noted about the two prior art references cited under this rejection is that they are both directed to spectrometers, whereas the present invention is directed to an ion delivery apparatus for directing ions through the entrance opening of a mass spectrometer. While both the present invention and the prior art relate to mass spectrometry, the differences in the intended functionalities of the instruments gives rise to some structural differences as well.

Clemmer, in an attempt to improve the measurement of large biomolecules by mass spectrometry, makes use of both an ion mobility spectrometer and a subsequent mass spectrometer, such as a time-of-flight mass spectrometer. As noted by the examiner, Clemmer uses the ion mobility spectrometer to separate ions prior to their acceleration in the time-of-flight mass spectrometer. The examiner is also correct in stating that Clemmer allows for the gating of electrons traveling through the ion mobility spectrometer so as to admit to the time-of-flight mass spectrometer only those ions falling within a predetermined ion mobility range.

In the case of the Lee reference, the examiner is again correct in stating that Lee discloses an ion mobility spectrometer that uses atmospheric pressure electrospray

ionization. Like Clemmer, Lee also discloses a drift tube in which an electric field is established in an axial direction that accelerate ions toward the ion output. However, both Clemmer and Lee differ from the present invention in that they are concerned primarily with maintaining a homogeneous electric field for the purposes of high resolution ion mobility spectrometry, and are not concerned with using the field to focus ions into an ion transfer port.

The present invention is directed to an apparatus and method for delivering ions generated at atmospheric pressure to a mass spectrometer. An ion cloud that is generated with an ion generator is coupled into an ion migration drift tube. Within the drift tube is a field-generating apparatus that produces a potential gradient that draws ions of the ionization cloud toward an entrance opening of the spectrometer. A gas port is provided through which gas may be introduced to the drift tube in a direction opposite to that of ion travel. Thus, as the ions of the ion cloud travel toward the entrance opening, solvent is stripped away by the counterflowing gas stream, so as to prevent its entry into the vacuum system of the mass spectrometer.

In contrast to the Clemmer and Lee references, the primary concern of the present invention is not the maintenance of a homogenous electric field in a tube connecting to a mass spectrometer. Rather, the present invention is directed to highly efficient delivery of ions to a mass spectrometer. In order to accomplish this, an electric field generated in the drift tube is structured in such a way as to help draw ions into the entrance opening of the mass spectrometer. In particular, the field includes curved equipotential surfaces that focus the ions toward the entrance opening of the mass spectrometer. This inhomogenous field greatly improves the efficiency of the conduction of ions into the mass spectrometer, guiding them toward the entrance opening.

The applicant's use of curved equipotential surfaces is discussed in the specification at, for example, page 12, lines 7-23. As stated therein, "[t]he curved equipotential surfaces in the drift tube have the effect of making the bundle of electric

field lines more and more tight inside the drift tube and therefore focusing the trajectories of the ion trail." This focus on ion trajectory is a departure from the ion mobility spectrometers of Lee and Clemmer, in which maintaining a uniform field is of utmost importance. In addition, it clearly delineates the present invention as a different type of device than those promulgated by Lee and Clemmer, that being an apparatus for the efficient introduction of ions generated by atmospheric pressure ionization to a mass spectrometer.

In order to more clearly point out the aforementioned aspects of the applicant's invention, Claim 1 has been amended to specify that the field-generating component of the claimed apparatus produces a DC potential gradient *with curved equipotential surfaces* inside the ion migration drift tube. Since the claim previously described the field as drawing the ions of the ionization cloud toward the entrance opening, this new language is not further limiting the scope of the claim, but more explicitly stating the nature of the fields used for guiding the ions in the drift tube. This language also clearly demonstrates one of the ways in which the present invention differs from the cited prior art. A similar amendment has also been made to Claim 23, which is a method claim that describes a method for feeding ions produced by atmospheric ionization into a mass spectrometer. This method claim, like Claim 1, has been amended to state that the ions are guided through a drift tube and into an entrance opening of the mass spectrometer with a DC potential gradient *having curved equipotential surfaces*. Nowhere in the Clemmer and Lee references, whether taken alone or in combination with each other, is there any suggestion of an apparatus or method for guiding ions generated at atmospheric pressure into a mass spectrometer using a potential gradient having curved equipotential surfaces. Claims 22 and 37 have been canceled. Claims 2-4, 11, 13 and 14 each depends ultimately from Claim 1, and Claims 24-26 and 33 each depends ultimately from Claim 23, and these claims are therefore equally unsuggested by the cited prior art. Reconsideration of Claims 1-4, 11, 13, 14, 23-26 and 33 under this ground for rejection is respectfully requested.

Claim 5 was rejected under 35 U.S.C. §103(a) as being obvious over Clemmer and Lee, in further view of U.S. Patent No. 5,965,884 ("Laiko"). The examiner has stated that Lee and Clemmer fail to disclose the use of pulsed lasers to generate an ionization cloud, and therefore cites Laiko for this purpose. However, the addition of Laiko to the combination of Clemmer and Lee does not render the combination any more suggestive of the applicant's claimed invention than the combination of Clemmer and Lee alone. There is no suggestion in this combination of an apparatus that guides ions generated at atmospheric pressure into the entrance opening of a mass spectrometer using a DC potential gradient having curved equipotential surfaces. Since this aspect of the invention is clearly recited in Claim 1, from which Claim 5 depends, Claim 5 is clearly unsuggested by the cited prior art. Reconsideration of Claim 5 under this ground for rejection is respectfully requested.

Claims 12 and 34 were rejected under 35 U.S.C. §103(a) as being obvious over the combination of Clemmer and Lee, in further view of U.S. Patent No. 4,712,008 ("Vora"). The examiner found that neither Clemmer nor Lee teaches the heating of a gas prior to its introduction to the drift tube. Vora is therefore cited as disclosing an ion mobility spectrometer for which heated gas is used. However, the addition of Vora to the combination of Clemmer and Lee does not render the combination any more suggestive of the applicant's claimed invention than the combination of Clemmer and Lee alone. There is no suggestion in this combination of an apparatus that guides ions generated at atmospheric pressure into the entrance opening of a mass spectrometer using a DC potential gradient having curved equipotential surfaces. Since this aspect of the invention is clearly recited in Claim 1, from which Claim 12 ultimately depends, as well as in Claim 23, from which Claim 34 ultimately depends, these claims are unsuggested by the cited prior art combination. Reconsideration of Claims 12 and 34 under this ground for rejection is respectfully requested.

Claims 6-10, 27-32 and 36 were rejected under 35 U.S.C. §103(a) as being obvious over the combination of Clemmer and Lee, in further view of U.S. Patent No. 6,239,428 ("Kunz"). The examiner found that Clemmer and Lee did not disclose

electron emission ionizers, beta particle emitting radioactive species ionizers or photoionization, and cited Kunz as describing the use of such ionizers with an ion mobility spectrometer. However, the addition of Kunz to the combination of Clemmer and Lee does not render the combination any more suggestive of the applicant's claimed invention than the combination of Clemmer and Lee alone. There is no suggestion in this combination of an apparatus that guides ions generated at atmospheric pressure into the entrance opening of a mass spectrometer using a DC potential gradient having curved equipotential surfaces. Since this aspect of the invention is clearly recited in Claim 1, from which Claims 6-10 ultimately depend, as well as in Claim 23, from which Claims 27-32 and 36 ultimately depend, these claims are unsuggested by the cited prior art combination. Reconsideration of Claims 6-10, 27-32 and 36 under this ground for rejection is respectfully requested.

Claims 15 and 18 were rejected under 35 U.S.C. §103(a) as being obvious over Clemmer and Lee in further view of U.S. Patent Application Publication No. 2002/0175278 ("Whitehouse"). The examiner has stated that Clemmer and Lee do not teach the use of an ion drift tube that is conical in shape, and has correspondingly added Whitehouse to the combination. Whitehouse discloses a multipole ion guide that uses RF and DC electric fields to guide ions, and that operates at atmospheric pressure. However, the ion funnel of Whitehouse does not used curved equipotential DC electric fields. Rather, DC fields are used for guiding the ions in an axial direction, while RF fields are used to trap ions (see, *e.g.*, paragraph [0048]). This is unlike the present invention, in which a DC potential gradient having curved equipotential surfaces is used to guide ions radially into an entrance opening of a mass spectrometer. Likewise, the combination of Clemmer, Lee and Whitehouse does not suggest this feature, which is explicitly recited in each of Claims 15 and 18 by virtue of their ultimate dependence from Claim 1. As such, reconsideration of Claims 15 and 18 under this ground for rejection is respectfully requested.

Claim 20 was rejected under 35 U.S.C. §103(a) as being obvious over Clemmer in view of Lee, and in further view of U.S. Patent Application Publication No.

2003/0089849 ("Guevremont"). The examiner cited Clemmer and Lee for the same reasons as discussed above with regard to the rejection to Claims 1 and 23, but noted that the Clemmer/Lee combination does not suggest the use of an ion drift tube with a curved shape. The Guevremont reference is therefore cited in combination with Clemmer and Lee. Guevremont discloses an analyzing apparatus that combines inductively coupled plasma (ICP) ionization with high-field asymmetric waveform ion mobility spectrometry (FAIMS) and mass spectrometry. In one embodiment of this system (shown in Figure 3), a FAIMS analyzer region of the instrument has curved electrodes 9 and 10 to which AC voltages are applied to direct ions to the orifice of skimmer cone 17. However, there is nothing in the prior art combination of Clemmer, Lee and Guevremont that is suggestive of using an apparatus that guides ions generated at atmospheric pressure into the entrance opening of a mass spectrometer using a DC potential gradient having curved equipotential surfaces. Since this aspect of the invention is clearly recited in Claim 1, from which Claims 20 depends, this claim is unsuggested by the cited prior art combination. Reconsideration of Claim 20 under this ground for rejection is respectfully requested.

The applicant acknowledge the allowance of Claims 16, 17, 19, 21 and 35. These claims have not been rewritten in independent form at this time, as it is believed that the claims from which they depend are now also allowable over the prior art of record.

In light of the foregoing amendments and remarks, it is respectfully requested that all the claims be allowed such that the application may be passed to issue. If it is believed that a telephone interview will help expedite prosecution of the application, the examiner is invited to call the undersigned. The Commissioner is hereby authorized to

charge any additional fees due for the filing of this paper to applicant's attorneys' Deposit Account No. 02-3038.

Respectfully submitted

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